

WHAT IS CLAIMED IS:

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1. A stereoscopic image displaying method,
wherein, when image information displayed on an image
displaying device is observed three-dimensionally by
5 guiding display light from an image corresponding to a
viewpoint of one parallax image on said image
displaying device, on which parallax images
corresponding to a plurality of different viewpoints
can be displayed, to an optical modulator, on which a
10 light transmitting section and a light shielding
section can be formed, by a second optical system
disposed in the front of said image displaying device,
and collecting the display light transmitted through
said light transmitting section of said optical
modulator at a position, which is a predetermined
15 distance apart, corresponding to the viewpoint on an
observation surface, by a first optical system, the
entire screen of a parallax image to be displayed on
said image displaying device is caused to be incident
20 on each eye by controlling transmitted light from said
optical modulator in synchronism with the switching of
parallax images to be displayed on said image
displaying device.

25 2. A stereoscopic image displaying method
according to claim 1, wherein
a first synthesized parallax image in which one

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stripe image is synthesized by dividing two parallax images for the right and the left eyes to horizontal stripe pixels, respectively, and arranging horizontal stripe pixels for the left and the right eyes in a predetermined order, and a second synthesized parallax image that is an interpolation image of said first synthesized parallax image which is synthesized by changing its order of arrangement are alternately displayed on said image displaying device.

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3. A stereoscopic image displaying method according to claim 2, wherein the change of said synthesized parallax image to be displayed on said image displaying device and the control for forming said light transmitting section and said light shielding section are performed synchronously for each pixel of said image displaying device or each scan line.

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4. A stereoscopic image displaying method according to claim 1, 2 or 3, wherein said optical modulator uses a liquid crystal shutter that has pixels of a matrix structure or an oblong pixel structure.

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5. A stereoscopic image displaying method according to claim 1, wherein

two parallax images for the right and the left eyes are alternately displayed on said image displaying device.

5 6. A stereoscopic image displaying method
according to claim 1, wherein
 said image displaying device emits predetermined
polarized light.

10 7. A stereoscopic image displaying method
according to claim 6, wherein
 said optical modulator has a first phase shift
member for giving two different phase shift states to
transmitted light by an electric signal and a polarized
15 optical device for partially transmitting predetermined
polarized light only which is provided in a
predetermined position to the front of said first phase
shift member.

20 8. A stereoscopic image displaying method
according to claim 7, wherein
said polarized optical device is configured by
arranging two polarization plates on which optical axes
are perpendicular to each other in a checkered pattern.

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9. A stereoscopic image displaying method
according to claim 7, wherein

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5 said polarized optical device is configured by alternately arranging two polarization plates on which optical axes are perpendicular to each other in the horizontal direction in a stripe pattern that is long in the vertical direction.

10 10. A stereoscopic image displaying method according to claim 7, 8 or 9, wherein

10 said polarized optical device comprises a second phase shift member and a polarizing plate, and its phase is processed as 0 and π in a pattern in which said second phase shift member is arranged in a checkered pattern or a stripe pattern that is long in the vertical direction.

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11. A stereoscopic image displaying method according to claim 6, wherein

20 said optical modulator has a first phase shift member for giving two different phase shift states to transmitted light by an electric signal, and said first shift member is arranged between said image displaying device and said second optical system.

25 12. A stereoscopic image displaying method according to claim 6, wherein

 said image displaying device has an automatic light emission display apparatus and a polarizing plate.

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13. A stereoscopic image displaying method according to claim 1, wherein a 2D image (an image without parallax) is displayed on a part of or the entirety of said image 5 displaying device.

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14. A stereoscopic image displaying method according to claim 1, wherein said second optical system focuses an image of 10 said image displaying device on said optical modulator in the vertical direction, and a focal point position of said second optical system and the position of said optical modulator substantially coincide with each other in the horizontal direction.

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15. A stereoscopic image displaying method according to claim 1, wherein said first optical system and said second optical system have predetermined periodic structures in the 20 horizontal direction, and said second optical system and/or said image displaying device are disposed on a face on which a multiplicity of straight lines cross, which connect the left and the right pupils and the center in the horizontal direction of each optical 25 element forming said first optical system.

16. A stereoscopic image displaying method

according to claim 1, wherein

5 said second optical system has a predetermined periodic structure in the horizontal and vertical directions, respectively, and said optical element forming one period in the horizontal and vertical directions has optical actions that are different in the horizontal direction and the vertical direction.

17. A stereoscopic image displaying method
10 according to claim 1, wherein

15 a crossing point of a multiplicity of straight lines that connect the left and the right pupils and the center in the horizontal direction of each optical element forming said first optical system, and the center in the horizontal direction of each optical device forming said second optical system coincide with each other, and/or the center in the horizontal direction of pixels forming said image displaying device coincide with them.

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18. A stereoscopic image displaying method
according to any one of claims 1, 2, 3 and 5, wherein
when the left and the right pupils are apart by an interval E, a period in the horizontal direction of
25 said optical element forming said first optical system is HL_1 , a width in the horizontal direction of said light transmitting section of said optical modulator is

Hm, a period in the horizontal direction of said optical element forming said second optical system is HL2, a pixel pitch in the horizontal direction of said image displaying device is Hd, optical distances between said first optical system and said second optical system and said first optical system and said image displaying device are LhL2 and Lhd, respectively, an optical distance from the observation surface to said first optical system is Lh0, an optical distance from a crossing face that is the first one counted from said first optical system in the direction to said image displaying device among faces on which a group of light beams connecting the left and the right pupils and each pixel of said image displaying device cross is Lh1, an optical distance from said first optical system to said optical modulator is Lh1a, an optical distance from said first optical system to a crossing face that is the first one counted from said first optical system in the direction to said image displaying device is Lh1b, and both Nd and NL2 are integral numbers of 2 or more, the following relation is realized:

$$Nd \cdot HL1/E = Lhd / (Lhd + Lh0) \dots (h1)$$

$$Hd/HL1 = (Lh0 + Lhd) / Lh0 \dots (h2)$$

$$NL2 \cdot HL1/E = LhL2 / (LhL2 + Lh0) \dots (h3)$$

$$HL2/HL1 = (Lh0 + LhL2) / Lh0 \dots (h4)$$

$$H1/E = Lh1 / (Lh1 + Lh0) \dots (h5)$$

$$H1/HL1 = (Lh1 + Lh0) / Lh0 \dots (h6)$$

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$$H1 \cdot Lh1a / Lh1 = HL1 \cdot Lh1b / Lh1 \dots (h7)$$

$$Lh1a + Lh1b = Lh1 \dots (h8)$$

$$Hm / H1 = Lh1a / Lh1 \dots (h9)$$

5 19. A stereoscopic image displaying method
according to claim 4, wherein

when the left and the right pupils are apart by an
interval E, a period in the horizontal direction of
said optical element forming said first optical system
is HL1, a width in the horizontal direction of said
light transmitting section of said optical modulator is
Hm, a period in the horizontal direction of said
optical element forming said second optical system is
HL2, a pixel pitch in the horizontal direction of said
image displaying device is Hd, optical distances
between said first optical system and said second
optical system and said first optical system and said
image displaying device are LhL2 and Lhd, respectively,
an optical distance from the observation surface to
said first optical system is Lh0, an optical distance
from a crossing face that is the first one counted from
said first optical system in the direction to said
image displaying device among faces on which a group of
light beams connecting the left and the right pupils
and each pixel of said image displaying device cross is
Lh1, an optical distance from said first optical system
to said optical modulator is Lh1a, an optical distance

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from said first optical system to a crossing face that is the first one counted from said first optical system in the direction to said image displaying device is Lh1b, and both Nd and NL2 are integral numbers of 2 or 5 more, the following relation is realized:

10 $Nd \cdot HL1/E = Lhd/(Ldh+Lh0) \dots (h1)$

$Hd/HL1 = (Lh0+Lhd)/Lh0 \dots (h2)$

$NL2 \cdot HL1/E = LhL2/(LhL2+Lh0) \dots (h3)$

$HL2/HL1 = (Lh0+LhL2)/Lh0 \dots (h4)$

15 $H1/E = Lh1/(Lh1+Lh0) \dots (h5)$

$H1/HL1 = (Lh1+Lh0)/Lh0 \dots (h6)$

$H1 \cdot Lh1a/Lh1 = HL1 \cdot Lh1b/Lh1 \dots (h7)$

$Lh1a+Lh1b=Lh1 \dots (h8)$

$Hm/H1 = Lh1a/Lh1 \dots (h9)$

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20. A stereoscopic image displaying method according to any one of claims 1, 2, 3 and 5, wherein when a pixel pitch in the vertical direction of said image displaying device is Vd, a width in the vertical direction of said light transmitting section or said light shielding section of said optical modulator is Vm, an optical distance from said image displaying device to a face having optical actions in the vertical direction of said second optical system is Lv1, an optical distance from a face having optical actions in the vertical direction of said second optical system to said optical modulator is Lv2, a

5 focal distance in the vertical direction of each
optical element forming said second optical system is
fv, and an optical distance between said optical
modulator and an observation surface is Lv0, the
following relation is realized:

$$Vd:Vm=Lv1:Lv2 \dots (v1)$$

$$2 \cdot Vd:VL=Lv1+Lv2:Lv2 \dots (v2)$$

$$1/Lv1+1/Lv2=1/fv \dots (v3)$$

$$Vd:VL=Lv0+Lv1+Lv2:Lv0+Lv2 \dots (v4)$$

10 21. A stereoscopic image displaying method
according to claim 4, wherein
when a pixel pitch in the vertical direction of
said image displaying device is Vd, a width in the
15 vertical direction of said light transmitting section
or said light shielding section of said optical
modulator is Vm, an optical distance from said image
displaying device to a face having optical actions in
the vertical direction of said second optical system is
20 Lv1, an optical distance from a face having optical
actions in the vertical direction of said second
optical system to said optical modulator is Lv2, a
focal distance in the vertical direction of each
optical element forming said second optical system is
25 fv, and an optical distance between said optical
modulator and an observation surface is Lv0, the
following relation is realized:

Vd:Vm=Lv1:Lv2 ... (v1)
2·Vd:VL=Lv1+Lv2:Lv2 ... (v2)
1/Lv1+1/Lv2=1/fv ... (v3)
Vd:VL=Lv0+Lv1+Lv2:Lv0+Lv2 ... (v4)

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22. A stereoscopic image displaying method
according to claim 18, wherein
when a pixel pitch in the vertical direction of
said image displaying device is Vd, a width in the
10 vertical direction of said light transmitting section
or said light shielding section of said optical
modulator is Vm, an optical distance from said image
displaying device to a face having optical actions in
the vertical direction of said second optical system is
15 Lv1, an optical distance from a face having optical
actions in the vertical direction of said second
optical system to said optical modulator is Lv2, a
focal distance in the vertical direction of each
optical element forming said second optical system is
20 fv, and an optical distance between said optical
modulator and an observation surface is Lv0, the
following relation is realized:

Vd:Vm=Lv1:Lv2 ... (v1)
2·Vd:VL=Lv1+Lv2:Lv2 ... (v2)
25 1/Lv1+1/Lv2=1/fv ... (v3)
Vd:VL=Lv0+Lv1+Lv2:Lv0+Lv2 ... (v4)

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23. A stereoscopic image displaying method according to claim 19, wherein

when a pixel pitch in the vertical direction of said image displaying device is V_d , a width in the vertical direction of said light transmitting section or said light shielding section of said optical modulator is V_m , an optical distance from said image displaying device to a face having optical actions in the vertical direction of said second optical system is 5 L_{v1} , an optical distance from a face having optical actions in the vertical direction of said second optical system to said optical modulator is L_{v2} , a focal distance in the vertical direction of each optical element forming said second optical system is 10 f_v , and an optical distance between said optical modulator and an observation surface is L_{v0} , the 15 following relation is realized:

$$V_d : V_m = L_{v1} : L_{v2} \dots (v1)$$

$$2 \cdot V_d : V_L = L_{v1} + L_{v2} : L_{v2} \dots (v2)$$

20 $1 / L_{v1} + 1 / L_{v2} = 1 / f_v \dots (v3)$

$$V_d : V_L = L_{v0} + L_{v1} + L_{v2} : L_{v0} + L_{v2} \dots (v4)$$

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24. A stereoscopic image displaying method according to any one of claims 1 through 3, 5 through 9 25 and 11 through 17, wherein

said first and second optical systems have lenticular lenses.

25. A stereoscopic image displaying method according to claim 4, wherein said first and second optical systems have lenticular lenses.

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26. A stereoscopic image displaying method according to claim 10, wherein said first and second optical systems have lenticular lenses.

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27. A stereoscopic image displaying method according to claim 18, wherein said first and second optical systems have lenticular lenses.

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28. A stereoscopic image displaying method according to claim 19, wherein said first and second optical systems have lenticular lenses.

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29. A stereoscopic image displaying method, wherein each of parallax images corresponding to a plurality of different viewpoints is made a predetermined stripe image, display light, which is from a stripe image corresponding to one viewpoint of a synthesized parallax image on an image displaying device that can alternately display a synthesized

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parallax image in which the stripe images is arranged
in a predetermined order and synthesized and a
synthesized parallax image in which the arrangement is
changed, is guided to an optical modulator, which is
5 formed in synchronism with the change of a synthesized
parallax image that displays a predetermined pitch of
light transmitting section and light shielding section
by a second optical system disposed in the front of
said image displaying device, display light that has
10 transmitted through said light transmitting section of
said optical modulator are collected at a position
corresponding to a viewpoint on an observation face by
a first optical system, and stereoscopic observation of
image information displayed on said image displaying
15 device is thereby performed.

30. A stereoscopic image displaying method
according to claim 29, wherein
display light reaching a viewpoint position of an
20 observer that correspond to the stripe image among said
display light emitted from pixels forming each of said
stripe image is collected in said optical modulator so
as to be transmitted through said light shielding
section of said optical modulator by said second
25 optical system, and the other light is shielded by said
light shielding section.

31. A stereoscopic image displaying method according to claim 29 or 30, wherein said second optical system forms an image of pixels of said image displaying device on said optical modulator in the vertical direction, and a focal point position and the position of said optical modulator substantially coincide with each other in the horizontal direction.

10 32. A stereoscopic image displaying apparatus,
wherein a stereoscopic image displaying method
according to any one of claims 1 through 3, 5 through 9
and 11 through 17 is used.

15 33. A stereoscopic image displaying apparatus,
wherein a stereoscopic image displaying method
according to claim 4 is used.

34. A stereoscopic image displaying apparatus,
20 wherein a stereoscopic image displaying method
according to claim 10 is used.

35. A stereoscopic image displaying apparatus,
wherein a stereoscopic image displaying method
according to claim 18 is used.

36. A stereoscopic image displaying apparatus,

wherein a stereoscopic image displaying method
according to claim 19 is used.

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37. A stereoscopic image displaying apparatus,
5 wherein a stereoscopic image displaying method
according to any one of claim 29 or 30 is used.

38. A stereoscopic image displaying apparatus,
wherein a stereoscopic image displaying method
10 according to claim 31 is used.